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ABSTRACT

Employed and retired engineers and scientists are increasingly being recognized as an underused resource for responding to the need to recruit persons to become qualified teachers of science and mathematics in elementary and secondary schools and to enrich the science curriculum. Two strategies predominate to use this resource. To increase the supply of qualified teachers, one strategy is the recruitment by schools of education of scientists and engineers seeking career change while still employed or in preparation for retirement, to enable them to become certified as full time, regular teachers. A variation of this approach, as allowed under the Education Improvement Act of 1984, is for scientists to begin teaching with provisional certification, and obtain full certification within 5 years. The second strategy, used to enrich science curriculum, is to recruit working and retired scientist and engineers, most of whom are not certified as teachers, to volunteer in science and math classrooms or in after-school activities--usually on a part-time or one-time basis. The National Institute for Work and Learning (NIWL) has surveyed a sample of programs using these strategies, which are summarized in this report. Sections include (1) "Introduction"; (2) "Need"; (3) "Special Initiatives"; (4) "Non-Traditional Programs to Provide Teacher Certification"; (5) "Scientists as Volunteers in the Classroom"; and (6) "Conclusions and Recommendations." Appendixes provide lists of programs and contact persons (17 entries). (KR)

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SCIENTISTS IN THE CLASSROOM: TWO STRATEGIES

BY

SHIRLEY R. FOX

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Thanks must also be expressed for the support of my colleagues, especially Veronica Jenkins for her ongoing, cheerful assistance in the production of this report.

SCIENTISTS IN THE CLASSROOM: TWO UTILIZATION STRATEGIES

I. INTRODUCTION

Employed and retired engineers and scientists are increasingly being recognized as an underutilized resource for responding to the need to recruit persons to become qualified teachers of science and mathematics in elementary and secondary schools; and to enrich the science curriculum being taught. Two strategies predominate to use this resource. To increase the supply of qualified teachers, one strategy is the recruitment by schools of education of scientists and engineers seeking career change while still employed, or in preparation for - or after - retirement, to become certified as full time, regular teachers. A variation of this approach, as allowed under the Education Improvement Act of 1984, is for scientists to begin teaching with provisional certification, and obtain full certification within five years. The second strategy, used to enrich science curriculum, is to recruit working and retired scientists and engineers, most of whom are not certified as teachers, to volunteer in science and math classrooms or in after-school activities - usually on a part time or one time basis.

The National Institute for Work and Learning (NIWL), under a grant from the GTE Foundation, has surveyed a sample of programs using these strategies which are summarized in this report. NIWL is also developing additional action-oriented strategies to improve the preparation of students in the sciences, both those preparing for professional science careers and those who will benefit from greater literacy in science and technology.

II. NEED

In its 1983 yearbook, Science Teaching: A Profession Speaks, the National Science Teachers Association (NSTA) stated that "According to NSTA's fall 1982 survey, 32,000 classes in science and mathematics could not be scheduled in 1982-1983 for lack of teachers and/or resources...Of the 17 million children in grades 8-12 this school year (1982-1983), 6.3 million are not taking science, and 6.4 million are not taking math." Extrapolation of unpublished data from a later survey of over 2000 high schools and 8500 science teachers indicates that in the 1985-86 school year more than 7000 high schools, (29.3 percent) offered no physics classes and 91.3 percent offered three sections or less. More than 4000 high schools (17.1 percent) offer no chemistry; almost 1900, (7.6 percent) offered no biology.

III. SPECIAL INITIATIVES

Two programs recruit trained scientists at different stages in their careers, one, retired military personnel, and another, those about to retire. They are discussed below.

A. Departments of Education and Defense - Retired Military

A special initiative was launched in late October 1986 by the Secretaries of Defense and Education to attract retired military personnel with scientific training to become certified as teachers and school administrators. A booklet entitled "A Second Career for You" will be distributed by retired officers' associations and veterans' groups to help recruit from this target group. At a ceremony announcing this initiative, Defense Secretary Weinberger stated that

Retired military men and women have had many years teaching, administering, training and leading large numbers of young people....We plan to let our retired and retiring military people know the opportunities for a second career in education, either teaching or administration....Today, with life spans reaching into the 70's our retired military truly do have time for a second career. The average officer retires at

less than 46 years of age. In 1985, 90 percent of the retiring officers had a bachelor's degree, and 63 percent of those had a master's degree, and four percent a Ph.D. The average enlisted person retires at less than 41 years of age. In 1985, 40 percent of the retiring enlisted population had had some college or completed an associate or baccalaureate degree. Each year, about 8,000 officers and 22,000 enlisted people retire.

The Retired Officers Association, over 25 years ago, established a retired officers placement service (TOPS) to inform employers, including schools, of skills available among retired military personnel and to match employer needs with retirees. No special effort was made, however, to involve schools of education to provide certification.

At the press conference, Secretary of Education Bennett added,

Many retirees are well-versed in precisely the subject areas in which there sometimes tend to be teacher shortages, namely science, math and foreign languages. Because more teachers are needed, many states are now liberalizing their certification requirements to allow qualified people, other than education school graduates, to enter the teaching profession....Every teacher should be well versed in his subject area, able to communicate effectively, and of sound moral character. Retired servicemen and women often meet all three of these requirements.

B. Pre-retirement recruitment

The National Executive Service Corps has received a grant from the Carnegie Corporation to study the feasibility of attracting persons with technical degrees, who are at least 45 years old and currently employed, to become certified teachers before retirement. The study is being administered by a loaned executive from IBM. About 6000 persons employed in eight companies and the Naval Base in San Diego, CA will be sent questionnaires, designed by the Educational Testing Service. Responses will be analyzed to assess the feasibility of attracting these persons to teaching, to identify the obstacles which must be overcome, and to determine what needs to be done to implement an effective program with teachers' unions and schools of education. These schools will be questioned as to their acceptance of work experience for academic

credit, particularly for those who have been trainers in their companies. Educational courses may be offered at company sites by public or private universities, as has been done in Syracuse, NY at the GE plant. The program will not involve full time course work, and it is hoped that even the practice teaching can be done during two periods while the person is still employed prior to retirement. The report should be completed in early 1987.

IV. NON-TRADITIONAL PROGRAMS TO PROVIDE TEACHER CERTIFICATION

To fill teacher shortages in a number of disciplines, some schools of education have initiated nontraditional approaches to attract persons trained in the discipline to be taught and to certify them as teachers in a shortened time frame. Three of the programs described below received funding from the U.S. Department of Education; one was supported by a state government; and others by the school systems for which the teachers were certified.

Some certification programs are part time, allowing two to three years to complete. Others are full time and can be completed in one year or less. Those in private universities may have high tuition costs, sometimes subsidized by the employer of the person who wishes to make a career change, is about to retire, or who may be part of a reduction in workforce. Some students may receive tuition assistance from the school district in which they will be employed. Most programs require at least a bachelor's degree in a science, a specified average grade point in previous academic work, and a certain number of years of related work experience. Programs are generally small, with 10-20 students per year.

Certification criteria

Scientists and engineers wishing to become certified teachers must meet criteria which are determined by the state in which they are employed. Selective reciprocity exists among some states which accept as certified those teachers who have passed the requirements for State Approved Teacher Certification in another state; e.g. Florida has reciprocity with 31 states, but not with Texas, which requires specific courses in American history and Texas government. Massachusetts has reciprocity with over 20 states primarily in the Northeast, but not with Connecticut. Some states allow persons to teach in the respective state who pass a lesser test which is not accepted by other states.

William Aldridge, Executive Director of the National Science Teachers Association (NSTA), after considering recently analyzed data, has concluded that NSTA many have been wrong in establishing a certification credential which requires 50 hours of undergraduate work in a particular science discipline. He stated that 70 percent of current high school teachers could not meet that requirement. Rather, he concluded, science education organizations should work to broaden the training of science teachers, because the market demands teachers with at least three fields of specialization for multiple assignments.¹

Some states have established an "alternate route", which allows persons to teach before obtaining certification. New Jersey has a Provisional Teacher Program, in which about 400 teachers have participated. The New Jersey program allows persons with solid academic preparation in the subject(s) to be taught, and the skills needed for teaching, to take formal instruction in education concurrently with a teaching assignment. A professional support team from the school district provides on-the-job supervision, support and evaluation.

¹ "Startling Data Upset Certification Program for Science Teachers", Education Week, September 24, 1986.

Scientists and engineers who consider entering the teaching field do so for many of the same reasons given by those entering training for the profession directly from undergraduate school. These include: the desire to contribute to society; the wish to be in a more people-oriented job than the industry job held; the attraction of a teacher's vacation and hourly schedule; and the chance to use their knowledge of the field to motivate and stimulate the interest of students. Some, however, express apprehension about their ability to relate to younger people and about their acceptance by school administration and teaching staff.

To date there has been no comprehensive follow-up of scientists certified to teach through non-traditional programs as to their retention as teachers or the quality of their instruction. The RAND Corporation has been funded by the Ford Foundation to conduct a study of nontraditional programs, but these issues are not included in the initial study. They may be proposed for later research. Some programs have experienced difficulty in recruiting a sufficient number of scientists and have broadened the disciplines from which students are recruited and in which they are trained to teach. This paper examines a few programs which have recruited primarily trained scientists and engineers desiring a career change, about to retire, or already retired.

Programs in the following schools of education are described in this report:

Fairleigh Dickinson University, Teaneck, NJ
George Washington University, Washington, D.C.
George Mason University, Fairfax, VA
Harvard University, Cambridge, MA
Johns Hopkins University, Baltimore, MD
University of Bridgeport, CT
University of Vermont, Burlington, VT
University of West Florida, Pensacola, FL
Washington University, St. Louis, MO
West Chester State University, West Chester, PA

In addition, a program in the State of Delaware involving several colleges and universities is included. Contact persons are listed in Appendix I.

Program descriptions

Fairleigh Dickinson University, Teaneck, NJ: SCATS-SECOND CAREER ALTERNATIVES IN TEACHING FOR SCIENTISTS

SCATS was begun in 1986, funded by the Fund for the Improvement of Postsecondary Education (FIPSE) of the U.S. Department of Education for a period of three years. Up to 15 SCATS Fellows will be selected each year. To qualify for the program, an applicant must have a Bachelor's degree that includes at least 30 credits in an appropriate discipline, work experience in a scientific industry, and have attained at least a 2.5 grade point average on previous academic work. In addition to scientists currently employed who wish to change careers, or who have already retired, some applicants are women re-entering the workforce.

The program is centered around a practicum. Fellows will begin teaching during the summer of 1987 after a two week introductory course. Their performance in the classroom will be monitored by professionals from the school district and university. With provisional certificates they will then teach during the regular school year, working with a mentor assigned by the respective school. During that time they will also take one education course each semester.

Tuition is being paid by the FIPSE grant, and Fellows are paid \$18,500 by the school systems for teaching during the school year. By the end of the training, to achieve regular certification as provided under New Jersey's "alternate route" program, the candidate must meet New Jersey's mandated score on the National Teachers Examination in biological, physical or comprehensive science.

George Mason University, Fairfax, VA: SWITCHER PROGRAM

The "Switcher" program, an alternative program for the preparation of science teachers, began in the 1985-1986 school year, funded for three years by the Office of Educational Research and Improvement (OERI) of the U.S. Department of Education. Students must have at least a baccalaureate degree with a major in physics, chemistry, or geology (earth science), a minimum grade point average of 2.75, three years of experience in their field, and have passed a computer literacy test and other examinations. For the maximum of 12 students per semester, the Director has received inquiries from about 200 persons. Some who don't qualify are referred to a "5th Year" program during which they take the same basic courses as do those in the Switcher program, but must practice teach for one full semester rather than for the eight weeks required by Switcher.

Required courses for this non-degree program include: elements of secondary education, psychological foundations of adolescent behavior, and secondary science methods. Courses are intensive and cover in one semester a full year's curriculum. Upon completion of the course work, students practice teach for eight weeks.

Eight students were graduated the first year, two of whom are retired military personnel. Five are teaching, and the other three are expected to have teaching positions soon. Seven students are currently enrolled, two with PhD's. Although Virginia has reciprocity with 39 states and the District of Columbia, most students want to remain in Virginia.

George Washington University, Washington, D.C: CAREER CHANGE

The School of Education and Human Development (SEHD) initiated a Master of Arts in Education program in the fall of 1985 to provide teacher certification for scientists, engineers or computer specialists. Persons were recruited from private industry, government agencies and the military, primarily through the

distribution of a brochure, "Build a Second Career on the Strength of Your First". Twenty one students were enrolled in the 1986-1987 school year.

The program focuses on preparing persons to teach math and/or science courses to students in grades 7-12. Degree candidates must complete a total of 36 credit hours in education, including at least 10 weeks of student teaching under the joint supervision of a master teacher and University faculty. Full time students may complete the program in three semesters if they carry 12 credit hours each semester. Part time students usually complete the program in two years. Most students are preparing to teach physics and mathematics.

The University program has reciprocity with 30 states and the District of Columbia.

Harvard University, Cambridge, MA: MID-CAREER MATH AND SCIENCE PROGRAM

Harvard began its Master of Arts in Teaching program for persons seeking mid-career changes in the 1983-1984 school year, and has graduated 40 students since then, 38 of whom are teaching. About 25 students have enrolled in the program for the 1986-87 school year. The number of students accepted was initially kept small as the program was intended to be a model for other teacher education programs.

Most students are seeking to change careers and range in age from 23-65. Some receive tuition aid from their employers and are encouraged to use their work experience in developing curriculum plans. Harvard receives from 500-600 inquiries each year from persons expressing interest in teaching.

Students are required to take four education courses: adolescent development, the role of schools, and two courses in teaching methods; two electives; and to participate in practice teaching for a period of 12 weeks. The program encourages interaction between teachers and professionals in the workforce. Students prepare to teach biology, chemistry, math, physics, general

science and a combined course of math and science for students in grades 5-9 in middle schools and 9-12 in high schools. The Massachusetts teaching credential that candidates receive has reciprocity with over 20 states.

Johns Hopkins University, Baltimore, MD: MASTER OF ARTS IN TEACHING

Johns Hopkins began its program in 1986 and recruits mostly scientists approaching retirement. The majority of the twenty students are enrolled part-time while continuing to work in industry.

Students must complete 36 credits, 21 in education and 15 in content areas which enable them to teach more than one subject and broaden their background. Included are courses in the philosophy of mathematics, earth science, and the use of computers in the classroom. The University is also developing a multidisciplinary science program to include "science and culture" and "research in the classroom."

A related program with industry for current secondary science teachers includes an in-service program which provides research opportunities during the summer. The University is planning a two year summer enrichment program which will include one summer at the University and the second in industry.

University of Bridgeport, CT: PROJECT SWITCH AND TEACHER INTERNSHIPS

Project Switch began in 1983 to provide shortened courses to enable scientists and engineers to become certified teachers in a 15 month period. Classes were held in the evenings and weekends. Since it began, fifteen students have been certified all of whom are now teaching. However, because not enough students could be recruited for the certification-before-teaching program, this project has been discontinued. Persons trained in the sciences are now being recruited for an internship program, because of the still existing shortage of science teachers. This program allows qualified scientists to be substitute teachers for one year while taking the required courses to become

certified. The school system in which the scientist is employed pays reduced tuition to the University and stipends to the student/teacher.

University of Vermont, Burlington, VT: TEACHER PREPARATION PROGRAM FOR PROFESSIONAL ENGINEERS, SCIENTISTS, AND MATHEMATICIANS

This program began in 1983 as a component of the University's Fifth Year Certificate in Education Program for persons desiring to become teachers upon retirement from science and math related jobs. The program has not been highly utilized. Some potential students have chosen instead to attend the program at Harvard.

The one-year program requires courses in methodology and pedagogy, supervised practice teaching, and a refresher course in the subject area for a total of 30 semester hours. Some employers have provided tuition assistance for their employee students.

University of West Florida, Pensacola, FL: MATH/SCIENCE INITIATIVE

The Math/Science Initiative was started in 1983 at the suggestion of the Commander of Naval Education and Training at the Naval Technical Training Center in Pensacola, in response to a request from Florida's Governor, Robert Graham, for help from the military in addressing the shortage of math and science teachers in the state. In addition to those seeking teaching credentials, military personnel have served as volunteers, judging science fairs, helping with science laboratories, and tutoring math students. The Pensacola project seems to have been the catalyst for the recent initiative of the Departments of Defense and Education in seeking retired military nationwide to become teachers and administrators in secondary schools, discussed earlier in this paper.

Officers and NCO's (non-commissioned officers) are enrolled in the program, mostly on a part time basis. Many have technical degrees; some can use their experience as instructors and trainers on the base for a partial credit of six hours against the required ten practice teaching hours. Education courses are

held at the base on a flexible schedule for most courses. For those who wish to change disciplines and need intensive instruction, or if the demand for a particular course is small, courses are held at the university campus.

Florida has reciprocity with 31 states for students taking the State Approved Teacher Certification, which requires more substantive content knowledge than other state certification which allows persons to teach in Florida. The state of Florida has also given school systems the option of waiving the traditional teacher certification requirements for those with advanced degrees and experience in their field (an "alternative route"). Such persons take an abbreviated program after they begin to teach. Many school systems, however, have not taken advantage of the waiver.

Washington University, St. Louis, MO: POST A.B. TEACHER CERTIFICATION PROGRAM

Preparation as teachers for mid-career professionals is part of a teacher certification program begun more than ten years ago in the Department of Education, administered through University College at Washington University. This program includes disciplines other than science and math. In 1981, however, chemical engineers about to be laid off from Monsanto Company, which was shifting emphasis from petroleum to biotechnology, constituted the single largest group in the program. Monsanto employees no longer predominate, and the company no longer provides tuition assistance for employee/students.

All students must have completed at least an undergraduate degree; some have graduate degrees. They must complete six education courses of three units each and six units of practice teaching. It is possible to complete the coursework in one year, but many students take two or three years on a part time basis taking courses at night in the University College. Student teaching is usually done for six weeks during a summer.

The University also has a Master of Arts in Teaching (MAT) program conducted by the Graduate School of Arts and Sciences, whose tuition is substantially higher than in the University College and whose admission requirements are competitive. Advantages of the MAT degree are that the Masters Degree is typically completed in fifteen months, has considerable financial aid, and includes courses in the subject to be taught as well as in education. It also commands a higher teacher salary than the certification without the advanced degree.

West Chester State University, West Chester, PA: MIDCAREER CHANGE PROGRAM

West Chester State University in 1983 received a three year grant from the Fund for the Improvement of Postsecondary Education (FIPSE) for an Industry to Classroom project to 'retread' persons taking early retirement. In the third year, the name was changed to Mid-Career Change Program, when it was not possible to recruit sufficient about-to-retire persons, and younger scientists were enrolled. At the end of the funded period, the project was terminated but the University is still 'retreading' persons through its traditional teacher training program and not restricting preparation to science and math.

Students generally are enrolled part time and take more than one year to complete the education course requirements.

State of Delaware: CRITICAL SHORTAGES

As a result of a Task Force established under Governor DuPont to study secondary schools in the state, critical shortages were identified and a half million dollars in state funds were later appropriated by Governor Castle for a three year effort to alleviate the shortages. Each county received \$10,000 to recruit technically trained persons to enrich science teaching, and a program was developed by the State Superintendent for Science and Environmental Education to retrain scientifically literate persons to become certified science

teachers. Tuition reimbursement is provided by the state for the teacher certification program, primarily to scientists from the chemical industry and from the Air Force Base in Dover. Those scientists who need more than six additional hours in content courses are not eligible. Education courses can be taken at the University of Delaware or at Delaware State College, Glassboro State College, NJ, West Chester State University, PA, or Salisbury State College in Maryland, provided the cost does not exceed that at the University of Delaware.

Delaware certification requires 15 credits in education, including the practice teaching. The state pays for up to six credits a semester, so that these courses can be completed in one year. Some in the program take longer, as there is no time limit for completion. All courses must be approved if tuition reimbursement is to be provided. Most new teachers will start at the junior high school level and teach general science as well a specific discipline.

V. SCIENTISTS AS VOLUNTEERS IN THE CLASSROOM

In many communities, practicing and retired scientists are being asked to share their expertise with students in the classroom, at the work site, or during field trips; and to help organize and judge science fairs and career days. Several professional organizations, such as the American Chemical Society, have encouraged their members to volunteer in the classroom. For example, in Wilmington, Delaware, Chemvets, an organization of retired chemists, has 'adopted' elementary schools for which it has developed lesson plans and provided support for teachers with "scientists-in-residence." The Ford Foundation has funded math collaboratives in eleven cities to develop business/science education linkages; and the Triangle Coalition for Science and

Technology Education² is developing an inventory of local coalitions which link business and industry resources with elementary and secondary schools.

Programs described in this report include:

Critical Shortages, State of Delaware

The Montgomery Education Connection, Inc., Montgomery County, MD

Partners in Education, and Additions, Orlando, FL

PRISM, and Math Collaborative, Philadelphia, PA

Science/Math Education Project, Washington, DC

Senior Scientists and Engineers Volunteer Project, (AARP), Washington, DC

Program Descriptions

CRITICAL SHORTAGES: State of Delaware

Enrichment programs throughout the state, many of which are subsidized by the Dupont Corporation, Hercules, and ICI include: For students: "Meet the Scientist", for 3rd grade students in eleven elementary schools in the Brandywine District, through Chemvets which developed a curriculum through which students become aware of how scientists observe the world around them; tutoring of 11th and 12th grade students in physics and chemistry by retired scientists; an evening Seminar Series for 11th grade chemistry students (in 1985-1986, the history of chemical companies was discussed by scientists with 50 students from five high schools; and in 1986-1987, Great Moments in Chemistry); research projects with chemist mentors for gifted students. For teachers: Subsidized science teacher attendance at NSTA national and regional conferences; transportation, lodging and some meal costs are paid by Dupont, cost of substitute teacher is paid by school district; and a Speakers Bureau through which practicing scientists present programs for teachers at Dupont facilities or at the University of Delaware.

² The Triangle Coalition is composed of national organizations from education, science, engineering, medicine, business, industry, and labor, based at the National Science Teachers Association headquarters in Washington, D.C.

THE MONTGOMERY EDUCATION CONNECTION, INC., Montgomery County Schools, MD

The Montgomery Education Connection is a nonprofit foundation to develop business support for Montgomery County Schools. One of its first projects has been the development for science and math teachers of a computerized resource data base of personnel, information material, and on-site resources which teachers may use to obtain assistance for various types of activities in their classrooms and after school. For example, scientists, mathematicians or computer specialists can be identified and contacted to serve as speakers, tutors, mentors, consultants, judges, or on-site internship mentors. Summer jobs or internships for teachers can also be arranged using the data bank. All schools in the county are linked to the data bank. The Connection publishes a monthly newsletter and will provide monthly awards to teachers making best use of the data base.

PARTNERS IN EDUCATION, ADDITIONS, Orlando, FL

The Orange County School System has several programs which bring scientists and engineers - and material resources - into the classrooms to enrich science education, and also administers an apprenticeship program which places students in industry, at the Kennedy Space Center, and at the Naval Base in Orlando.

Through the Partners in Education program, businesses adopt schools for which they provide speakers in the classroom, field visits, monetary and material resources. The Additions Program is a computerized data base through which teachers can request persons to provide classroom presentations, many of which include hands-on activities.

Summer apprenticeships are arranged for students in the Summer High School Apprenticeship Research Program (SHARP) for women and minority students at NASA installations, where they work with scientist mentors for a ten week period, at the end of which they prepare a paper on the research conducted.

A corollary program in the private sector with the Martin Marietta Aerospace Corporation provides 12 juniors and seniors who have high grade point averages in math and science an 8-10 week paid summer work experience. Many students remain with the company as coop students through their college education.

PRISM: PHILADELPHIA RENAISSANCE IN SCIENCE AND MATH, and PHILADELPHIA MATH COLLABORATIVE, Philadelphia, PA

The PRISM program has provided a number of linkages between practicing scientists and science teachers. A Math/Science Clearinghouse provides a data bank from which teachers may request resources; PTIP-Philadelphia Teachers in Industry Program-arranges summer work experience for science teachers with practicing research scientists and provides follow-up support during the school year; a Speakers Program provides practicing scientist volunteers who "teach" in the classroom to allow the regular teacher to attend professional meetings; Lab Links brings together teachers and scientists to design research projects for the science classroom. A program not yet implemented would use retired engineers and scientists as tutors or workshop leaders for "family math" to involve parents in the education of their children.

Philadelphia is one of eleven cities funded by the Ford Foundation to develop urban math collaboratives, which will supplement the above programs in Philadelphia.

SCIENCE/MATH EDUCATION PROJECT, Washington, DC

The Science/Math Education Project was started in 1985 to provide volunteer personnel to assist math and science teachers of 7th grade students in the District of Columbia Public Schools. In 1986, 6th, 8th, and 9th grade teachers were also included. The project is administered by a person on loan under the Intergovernmental Personnel Act (IPA) from the National Science Foundation. It is sponsored by the Federal City Council (FCC), a non-profit, non-partisan

organization of civic leaders in business, education and the professions, and funded by the FCC; Aetna Life and Casualty, Meyer, Cafritz and Hattie Strong Foundations; the Philip Graham Fund; and the DC Public Schools.

As of June 1986, 240 persons had volunteered for the project, and 160 had been assigned to classrooms. Volunteers are practicing or retired scientists, engineers and mathematicians recruited from industry, government, and universities. They serve as guest instructors, provide seminars and workshops for teachers, field trips for students and teachers, and conduct after-school science and math clubs. Some spend as little as two hours per month or as much as four hours per week.

During the summer of 1986, junior high school and 6th grade teachers attended an institute to learn how to use volunteers effectively. The work of assigning and monitoring volunteers in their placements has been found to be a more complicated task than anticipated. The development of an automated database is being considered but may be too time consuming and expensive.

SENIOR SCIENTISTS AND ENGINEERS VOLUNTEER PROJECT, Washington, DC

Since 1982, the Volunteer Office of the American Association of Retired Persons (AARP) has recruited retired scientists, engineers and computer specialists to serve as volunteers in the schools and in the community. About 250 have registered, and about 100 have been active. The volunteers have served as tutors, visiting lecturers, and Science Fair judges. Most have served on a one-time basis; few are ongoing participants. The program was a pilot by the national office and is to be adopted by the Washington, D.C. area AARP office. As in similar programs, the task of matching volunteers with the schools proved to require more time than anticipated, and this program did not have staff to conduct continuing outreach and followup.

VI. CONCLUSION AND RECOMMENDATIONS

The demand for and supply of scientists and engineers for the workforce, for scientific research, and for defense change at different rates. The number of students needed to be trained in the sciences to enter the pipeline and, therefore, the number of teachers needed to prepare these students to meet expected demand will also vary. For the short term, there seems to be a consensus that a shortage of qualified teachers does, indeed, exist for which shortened certification programs or provisional certification for trained scientists are a partial solution. There is also concern about the appropriateness and quality of what is being taught. Those persons trained in the sciences who do not want to commit themselves to full time employment as certified teachers, but do want to be employed part time or volunteer their services in the classroom, should be recognized as an important resource to address this concern. They should not be perceived as a threat to the professional teacher, but used in a variety of ways, working under the direction of a classroom teacher.

A. Non traditional certification programs

Long-term comprehensive evaluations need to be carried out of the non-traditional teacher certification programs and "alternate route" programs currently in vogue to increase quickly the supply of qualified science and mathematics teachers in elementary and secondary schools. These programs should also be compared to programs whose purpose is to change the discipline taught by teachers already certified in another field. Some preliminary conclusions can be drawn, however, based on comments of those involved in the programs summarized here.

Collaboration between employers and schools helps

Local collaboration between schools of education and local employers facilitates these programs. Employers should be encouraged to provide released

time for about-to-retire scientists - or those about to be terminated because of plant closings or retrenchment - so that education courses and practice teaching can be completed while the prospective teacher is still employed. Schools should be encouraged to provide more flexible scheduling to accommodate the needs of those still employed. Employers should also be encouraged to provide tuition aid. Companies might also be asked to help screen interested employees to identify those deemed most suitable to become teachers.

Concerns

Concerns were expressed about the ability of older scientists to adapt to the rigid schedule of a teaching day and to the demands of a heterogeneous group of students. Younger scientifically trained persons seeking career change are considered better able to adapt to the classroom environment than older persons nearing retirement or already retired. Those retiring from the military, however, who may be no more than in their early 40's, may be able to make the adjustment. A high energy level is considered to be necessary to cope with the range of abilities and interests of junior and senior high school students. Public school systems are frequently considered too inflexible to adjust teaching loads and schedules to make it more feasible for older scientists to become teachers, and may discourage scientists from entering a certification program.

A corollary concern was expressed that some programs do not provide the opportunity for those considering career change to experience teaching before being committed to a certification program. Early practice teaching is recommended for those who have never taught.

Inflexibility was also seen as characteristic of many traditional schools of education which insist that certain content courses be taken and do not allow credit for knowledge of the subject(s) to be taught and experience in the field, even though the prospective teacher has a Ph.D. in the discipline and many years

of related work experience.

There is also concern that the shortened preparation in education methodology may not adequately prepare scientists to teach and to relate well to young students with varying degrees of interest in the sciences. It is felt that in some school districts there may not be sufficient monitoring and support to ensure quality instruction by these new teachers.

B. Volunteer scientists in the classroom

Good relations between employers and schools are also important for volunteer activities: to arrange for released time for practicing scientists to be able to serve as volunteers in the schools and, in some cases, for the provision of material resources. Volunteer scientists and engineers have been found to be an important resource for activities such as enriching curriculum, providing career information, conducting site visits, organizing science clubs for hands-on laboratory experience, judging science fairs, and tutoring students - those needing help and gifted students who need additional stimulation.

The administration of programs to match teacher needs with appropriate resources, however, can be costly and time consuming, and program effectiveness depends on a number of factors:

1. Knowledge by teachers of the availability of the resources.
2. The ability of the teachers to recognize gaps in a curriculum and the potential of the additional resources to provide students with information and skills adequate for the requirements of today's economy.
3. The ability of teachers to use volunteers effectively.
4. Ongoing administration of programs for the recruitment and matching of volunteers.

C. Additional Recommendations

To meet some of the concerns identified above, and to increase the benefits of the strategies discussed, it is recommended that:

1. Trained scientists considering entering teacher certification programs be given the opportunity to observe and participate in science classrooms at the grade levels to be taught before entering the education program, or very early in the program, perhaps through internships;

2. Traditional students in schools of education be integrated in some of the education courses with the experienced scientists enrolled in non-traditional certification programs rather than being isolated in separate classes as is done in many schools, so that they might benefit from the practical knowledge of the scientists;

3. Professional organizations, such as the American Chemical Society, be used more as a source of volunteers in the schools through their chapters of retired scientists;

4. Schools of education, local education agencies, and employers in the appropriate geographic area establish collaborative councils to identify the need for teachers, and coordinate the recruitment and placement of needed teachers;

5. Greater supervision and support be provided to newly certified teachers to assure their ability to adapt to the classroom environment;

6. Practicing teachers receive technical assistance on how to use volunteers most effectively; and

7. An evaluation be conducted as to the long term effect of the non-traditional education programs, alternate routes to certification, and the use of volunteers in the classroom in terms of quality of teaching, material and skills learned, and retention of science teachers.

APPENDIX I

CONTACT PERSONS FOR NON-TRADITIONAL TEACHER CERTIFICATION PROGRAMS

Fairleigh Dickinson University, Teaneck, NJ: SCATS-SECOND CAREER ALTERNATIVES
IN TEACHING FOR SCIENTISTS

Morris Lerner, School of Education, Fairleigh Dickinson University, Room 228,
Bancroft Hall, Teaneck, NJ 07666, 201-692-2467

George Mason University, Fairfax, VA: SWITCHER PROGRAM

Dr. Henry J. Bindel, Jr., Professor of Education, George Mason University,
Department of Education, 4400 University Drive, Fairfax, VA 22030, 703-323-2421

George Washington University, Washington, D.C.: CAREER CHANGE

Dr. Mary Louise Ortenzo, Director, Math/Science Education Program, School of
Education and Human Development, George Washington University, 2201 G Street,
N.W., Fonger Hall, Room 507, Washington, D.C. 20052, 202-676-6160

Harvard University, Cambridge, MA: MID-CAREER MATH AND SCIENCE PROGRAM

Dr. Katherine Merseth, Director, Teacher Training, Harvard University Graduate
School of Education, 224 Longfellow Hall, Cambridge, MA 02138, 617-495-3498

Johns Hopkins University, Baltimore, MD: MASTER OF ARTS IN TEACHING

Jo Ellen Roseman, Director, Johns Hopkins University, School of Continuing
Studies, 105 Whitehead Hall, Baltimore, MD 21218, 301-338-8273

University of Bridgeport, CT: PROJECT SWITCH AND TEACHER INTERNSHIPS

Dr. Louise Soares, University of Bridgeport, 285 Park Ave., Bridgeport, CT
06602, 203-576-4000

University of Vermont, Burlington, VT: TEACHER PREPARATION PROGRAM FOR
PROFESSIONAL ENGINEERS, SCIENTISTS, AND MATHEMATICIANS

Clinton Erb, Mathematics Education, University of Vermont, Burlington, VT 05402,
802-656-3356

University of West Florida, Pensacola, FL: MATH/SCIENCE INITIATIVE

Dr. William Halperin/Dr. Patricia Wentz, Center of Excellence, 10200 South
University, University of West Florida, Pensacola, FL 32514, 904-474-2741

Washington University, St. Louis, MO: POST A.B. TEACHER CERTIFICATION PROGRAM

Beth Okenfuss, Post A.B. Teacher Certification Advisor, Washington University,
Department of Education, Campus Box 1183, St. Louis, MO 63130, 314-889-6791

West Chester State University, West Chester, PA/MID-CAREER CHANGE PROGRAM

Charles Good, West Chester State University, 700 S. High Street, West Chester,
PA 19383, 215-436-2958

State of Delaware: CRITICAL SHORTAGES

John Cairns, State Superintendent, Science and Environmental Education, Townsend
Building, P.O. Box 1402, Dover, DE 19903, 302-736-4885; (Marcia Ranieri,
External Affairs Office, DuPont Corporation, 806 DuPont Plaza, Wilmington, DE
19898, 301-699-1741.

APPENDIX 2

CONTACTS FOR PROGRAMS FOR SCIENTISTS AS VOLUNTEERS IN THE CLASSROOM

CRITICAL SHORTAGES, State of Delaware

Dr. Michael Walls, Superintendent, Christina School District, 83 E. Main St., Newark, DE 19711, 302-454-2200; Mr. Frank Castelli, Superintendent, Curriculum, Brandywine School District, Pennsylvania Avenue, Claymont, DE 19703, 302-792-3834)

THE MONTGOMERY EDUCATION CONNECTION, INC., Montgomery County Schools, MD

Judith Messitte, Coordinator, Connection Bank, Room 129, 850 Hungerford Drive, Rockville, MD 20850, 301-279-3125

PARTNERS IN EDUCATION, ADDITIONS, Orlando, FL

Dallas Maddron, Program Consultant for Secondary Science, Orange County School System, Box 271, Orlando, FL 32802, 305-422-3200

PRISM: PHILADELPHIA RENAISSANCE IN SCIENCE AND MATH, and PHILADELPHIA MATH COLLABORATIVE, Philadelphia, PA

Sue Stetzer, Franklin Institute, 20th and Parkway, Philadelphia, PA 19103, 215-448-1238

SCIENCE/MATH EDUCATION PROJECT, Washington, DC

Ted Drury, Federal City Council, 1155 15th Street, NW, Washington, DC 20005, 202-223-4560

SENIOR SCIENTISTS AND ENGINEERS VOLUNTEER PROJECT, Washington, DC

Charlotte Nusberg, American Association of Retired Persons, (AARP) National Office, 1909 K Street, NW, Washington, DC 20049, 202-662-4929